National Aeronautics and
Space Administration
Goddard Space Flight Center
Greenbelt, MD 20771

Reply to Attn of: 421

February 23, 1995

Mr. Lee Tessmer
MODIS Program Manager
Santa Barbara Remote Sensing
75 Coromar Drive
Goleta, CA 93117

Dear Mr. Tessmer:

Attached for your information and use as enclosure 1 are the comments generated on the MODIS Quarterly Management Review held at SBRS on December 12-13, 1995. In general, the GSFC review team felt that very good technical progress had been demonstrated; however, concerns were raised over the problems occurring with the Sipex hybrids, connectors, and the vibration failures of several optical components. Consistent with our policy of open communication, these comments are being forwarded to you in their unedited form. Please note that the proposed action items identified in Dr. Godden's comments are proposals to the EOS-AM project and are not formal actions assigned to SBRS. This enclosure is forwarded for your information only.

Enclosure 2 is a list of the action items issued at the QMR. These action items are due 30 days from the date of receipt of this letter.

Enclosure 3 is a trip report from Mr. G. Daelemans (GSFC MODIS Thermal Engineering Lead Engineer) providing his observations and conclusions on the thermal test of the radiant cooler and aft optics assembly. He includes several recommendations for improving future tests. These recommendations are for your consideration only, and are not intended as, and should not be interpreted as, required actions for SBRS. This trip report is also included in summary form in enclosure 1.

If you have any questions on this letter or the enclosures, please contact me at (301)-286-6845.

Sincerely;

Kenneth Anderson

Kenneth Anderson
MODIS Technical Officer

enclosures (3)

~~Enclosure 3~~

cc:
284.4/MODIS Contracting Officer
421/R. Weber
421/D. Jones
421/S. Gorman
704.3/M. Roberto
724.3/G. Daelemans
925/B. Guenther
925/G. Godden
970/W. Barnes

Enclosure 3

GSFC COMMENTS ON DECEMBER 12-13 MODIS QUARTERLY MANAGEMENT REVIEW

1.0 SUMMARY

The QMR was held at Santa Barbara Remote Sensing on December 12 and 13. Lee Tessmer presented the program overview, and Tom Pagano presented systems engineering. Presentations in several other technical disciplines were given by other members of the SBRS MODIS team including Mary Ballard, Tom Kampe, Al DeForrest, Ed Clement, Ed Schultz, Russ Hudyma, Eric Johnson, Vern Alferd, Duane Bates, and Ed Schultz. Lori Youngman provided the business report on December 13.

This report provides an overall summary of the instrument technical and programmatic status at the time of the review. Comments are also included from GSFC MODIS personnel including George Daelemans, Jose Florez, Gerry Godden, Bob Martineau, and Eugene Waluschka.

2.0 PROGRAM OVERVIEW

Lee Tessmer provided the program overview. Considerable progress was made since the September QMR on the Protoflight Model (PFM). The aft optics assembly (AOA) was completed, a refurbished scan mirror and mainframe were delivered to systems integration and test (SI&T), scatter was measured on the integration and alignment collimator (IAC), the scan mirror was aligned to the reference cube, the afocal telescope assembly (ATA) was vibrated (but required a penalty vibration for the ATA fold mirror), and acceptance testing of the radiative cooler was completed along with a special thermal vacuum test of the AOA. An epoxy stripe was added to the entrance side of the PFM long wave infrared (LWIR) mask between bands 27 and 33 to eliminate crosstalk. The thermal testing of the ATA was completed. The band 26 filter was replaced on the short/mid wave infrared (S/MWIR) focal plane assembly (FPA). Integration of the optical bench assembly (OBA) was completed.

Progress was also made on flight models 1 and 2, particularly in the focal plane area.

At the time of the review, the schedule overview showed the PFM critical path with minus 32 days of float, due to electronics parts.

3.0 CONCERNS

The major programmatic concerns at the time of the review were electronics parts, annual budget caps, people, loss of schedule, and test readiness.

Near field response (NFR) remains a key technical concern. This is influenced by the quality and cleanliness of the optics.

4.0 SYSTEMS ENGINEERING

Tom Pagano described several tests which will be performed using Engineering Model (EM) electronics. These include response versus scan angle, field of view, polarization insensitivity, warm target within-field stray light, stray light rejection (using sun gun), and spectral response.

MODIS requirements were referenced to specific SBRS tests.

Signal to noise ratio (SNR), noise equivalent temperature change (NEΔT), and PFM margins to specifications (EM noise values were used) were presented. PFM SNR was low in bands 3, 4, and 8. NEΔT was high in band 24.

PFM spectral response profiles were modeled based on component data. There were some noncompliances in center wavelength, bandwidth tolerance, and edge range for which waivers were submitted.

Spatial registration at the OBA level met the goal as well at the specification.

In the area of structural analyses, revision B of the vibration specification was completed, correlation of modal survey test data and the MODIS math model was completed, the systems dynamics NASTRAN model was updated for main electronics module (MEM) section and mass properties. Positive margins of safety were found for the radiative cooler acoustic analysis, suspension band fatigue analysis, and invar mount ring stress analysis.

In structural testing, there was a failure of an attachment pin for the ATA fold mirror. An improved bonding process was then implemented. The penalty vibration validated the bonding process, but there was a crack on the fold mirror at the pin location. At the time of the review, failure analysis was in progress. The PFM radiative cooler assembly successfully passed workmanship vibration. The EM AOA was acceptance tested; the aft optics primary structure passed, but some optical elements were damaged. A new bonding process was implemented for the PFM. The PFM ATA was acceptance tested with the primary structure passing the test.

In the thermal area, the passive radiative cooler performance exceeds requirements. The standard Cold Focal Plane Assembly (CFPA) can be set at 83 K or lower. Unit level testing of the radiative cooler, AOA, and ATA was completed. The aft optics thermal test showed low margin in some bands.

The solar diffuser viewport scatter analysis ORDAS model was improved. The scatter requirement of less than 0.0025 at all angles is now met. Analysis of earthshine on the nadir viewport is in review.

Several other analyses were performed. Jim Young's memos included: IAC near field characterized; alternate bright target/dark target test concept defined; revised point spread function (PSF), line spread function (LSF) near field response (NFR) measurement methodology identified; radiometric calibration budgets updated; gravity effects on polarization source assembly (PSA) lamp assessed; and radiometric calibration effects of NFR evaluated. Tom Pagano identified electronic crosstalk impact to NFR.

SBRS and GSFC personnel met with LMAS personnel at Valley Forge on November 1. The strategy for spectral, spatial, and radiometric testing was identified. Issues and actions items included: SBRS will develop a real-time glitch monitor to facilitate compatibility testing, the use of the bench test cooler (BTC) during ambient performance tests was an issue, and the cleanliness in the thermal vacuum area at LMAS was not adequate.

At the time of the review, the mass, power, and data rates all looked good. The MODIS mass estimate was 221.4 kg, with a margin of 28.6 kg. The power estimate was 127.4 watts for the 1-orbit average, 143.5 watts for the 2-orbit average, and 162.5 watts for the peak power. The power margins to allocations were 97.6 watts, 81.5 watts, and 112.5 watts respectively. The average data rate was 6.1 Mbps average and 10.6 Mbps peak. The data rate margins to allocation were 0.1 and 0.2 Mbps respectively.

The following includes comments from the GSFC MODIS team:

5.0 GEORGE DAELEMANS (Thermal)

I really don't have comment per say on any of the dialog from the quarterly, because my interaction these days with SBRS tends to be on a continuum. One concern that is growing on my part is the accessibility of Ron Choo to the engineers at SBRS. I understand that he is a sought after commodity down in the HUGHES El Segundo facility. Give the myriad number of changes to the instrument thermal design due to the background noise, his ability to concentrate on the trickle down of problems is hampered. To cap this concern I do not see a ready solution. I cannot imagine any of the other EOS thermal engineers relocating to SBRS (e.g. Dave LaKomski) in a timely enough manner to prevent any of the daily decisions relating to the thermal design from catching up with the project later during verification.

The second concern is about GSFC's role in supplying the PFM unit's blankets. It has been my assumption that SBRS is in a cost constrained (i.e. FY cost caps) situation. We are offering a perfectly good set of blankets at little real cost to SBRS, yet they have continued to work towards being able to have a local vendor supply the blankets, (the "high fidelity model for the blanket fabrication has been completed) ostensibly for FM1 & FM2 in a time frame such that they will be ready for PFM and the decision to do so "has not been made". I have not been appraised of any technical nor programmatic reason for this course of action on SBRS part. I am willing to concede this course of action on their part; it is just a shame that we will have not gotten the most for our bucks on the EM blankets.

An additional concern is about the radiant cooler's BTC from the folks in Colorado (CTS). The cryogenic refrigerator unit is capable of providing the cooling necessary. The problems that remain are center around the unit's ability to control the temperature to a stability level suitable for the FPA's. The system was upgraded shortly before we arrived with a feedback loop but the sensor locations are remote from the region to be controlled (unavoidably). The mechanism that regulates the flow has insufficient movement over the flow range needed to control the nitrogen flow. The air pressure used to control the movement (diaphragm) also has minor variation which cause the system to become unstable. The owner of CTS does not seem to have much use or desire for any control systems type of assistance; however, it is my opinion that a small effort by a controls expert might solve the system's stability problems. The effort as I see it will be in the determination of the transfer functions that will correctly model the systems mechanical components.

Excerpts from a trip report from George Daelemans, dated December 7, 1995:
October, 1995, PFM radiant cooler/aft optics platform (AOP) thermal vacuum/thermal balance (TV/TB) test:

The purpose of this test was two fold; First to demonstrate, with the best simulation as possible, that the MODIS radiant cooler will have temperature margin when the instrument reaches orbit, and; second, to verify the post Engineering Model (EM) modifications performed to the Aft Optics Platform for reducing the background emissions were sufficient. Briefly, the cooler has a two degree margin (83K vs. spec 85K). Test simulation conditions were, I believe, truly worst case, and that the simulation set-up reduces the on orbit performance by 1.5K to 4.0 K. As of my departure it was clear the none of the channels saturated out-right, but since my return it is equally clear that the amount of temperature related background noise has not been reduced enough. The FPA/optics system that were under test will operate without additional fixes at the upper limit of temperature operations currently predicted for the instrument, but not at the prediction plus the 10°C qual limit buffer.

Observations

At contract award for the MODIS instrument the predicted margin for the proposed cooler was on the order of 1.5K. The project wisely decided to buy some margin and approved several changes to the cold stage radiator, outer stage radiator, aperture openings and the dewar stem. It was predicted that these changes would give the cooler an additional 4K or a total of 5.5K beyond our requirements for a 85K set point. The Nominal Temperature Load (NLT) test is essentially a indication of our margin. The unit settle out at 83K during the worst case NLT (mount ring @ EOL temp of 13K). Since we are testing hardware now, rather than analysis, and that the simulator has a few shortcomings while trying to approximate space, I feel comfortable that the instrument's cooler will meet the 85K orbital requirement.

The amount of additional margin from the Space Background Simulator (SBS) is still under analysis. However our best estimates to date of the improvement are as follows:

1) Cold stage to Cooler SBS effects, these include losses for "seeing" the edge of the outer SBS box, the third stage fin on a single bounce, reduction in stage FOV due to non perfect emittance of the simulator (vs. space), reflected view to intermediate stage. All of these effects yield approximately 1.61K of performance improvement in flight.

2) Intermediate stage reduced FOV from test conditions yields another .21K

3) Fixed temp instrument sink vs. floating instrument on orbit (testing limitation vs. reality) nets an additional .65K improvement in orbital performance.

4) The impact of the door sizing between test and flight yields an additional 1.19K, because the simulated door on the test article crowds the FOV more than it would on orbit.

5) Fin radiator FOV differences between test and flight (helps) and the inclusion of the fin's FOV to the earth door (hurts); net orbital effect .04K loss of performance from test to orbit.

6) Orbital heat rate as calculated by NASA model vs. SBRS calculations from 1992. Our cold stage loads are higher that SBRS's values but the loading on the intermediate and fin radiator stages are lower. The net effect of this is that our orbital prediction is .46K lower than SBRS's heat loads used in this test.

7) Warmer sink temperatures during the test will yield .13K orbital improvement since space is colder.

The summation of these effects is about 3.9K of improvement over what was observed during test, an additional 0.1K is still unaccounted for in the difference between the correlated model in the test conditions and the orbital predictions. This 4K improvement would yield an orbital Nominal Load Temperature of ~79K.

The background noise testing was performed during the first few of the AOP temperature cycles that were performed to meet the PAR thermal requirements. Three basic tests were performed. The first was with the FPA's fixed at 83K while the AOP was changed from one qualification temperature extreme to the opposite temperature extreme. While this was being done, the FAM SBS was held at a quasi-constant 180K to provide a "known" scene temperature. This sequence was repeated again at a FPA temperature of 85K while also holding the scene plate (a.k.a. FAM SBS) at 180K. The final test was performed with the AOP held constant at the high qualification temperature (29°C) while the FAM SBS was cycled up to 13°C and back to 180K. During each of these thermal events, the data for the FPA's was collected on ten minute intervals so that a smooth curve of the background radiation noise levels could be readily correlated with the temperature telemetry. It should be noted that the temperature data collection of the hardware in the chamber is not tied in automatically with the data being collected with the FPA's GSE (called the BAEM). Neil Therrien merged the data sets via a worksheet program after ascertaining difference in the two unit's clocks. While this method of data merging is acceptable for engineering evaluation, I do not think this type of data collection/documentation will be tenable for the Protoflight testing.

Environmental Testing at SBRC

I believe that SBRC needs to become at little more proficient at pulling together the resources for any of the major environmental testing that will be required for the remainder of the MODIS instrument verification. Here are some of my suggestions based on the few tests that I have tried to support at SBRC facilities:

1. Test plans; This simple little document seems to have created more frustration on both SBRC part as well as GSFC. It has always been my view that a test plan should be a short statement of what is to be tested, what the objectives of the test are to be, what equipment is necessary, what is the predicted performance, and any limitations on the test article (i.e. temperature ranges, or less than complete performance). The creation of this document will allow others who will be supporting the test to:

a*) Assemble and or schedule the needed GSE*

It seem to be chronic SBRC shortcoming that the minor GSE equipment and the MCC are not prepared until the flight hardware is placed in the chamber. As a re-occurring example, the Thermodynamics units are the most unreliable thermal conditioning units I have worked with in 17 years of testing. A tremendous effort is put forth by SBRC's people to maintain schedule only to have any gains lost by the poor performance of these thermal conditioning units. SBRC should have some leverage with the manufacturer to better support the performance of these units. The notion that the units can only be fine "tuned" with expensive NASA flight hardware in the chamber is disturbing, especially when I have witnessed a "tuned" unit suddenly lose control and plunge the plumbed space simulator to -100°C in a matter of a few minutes and have no one realize this condition for 15 or 20 minutes. Assembling the temperature telemetry harnessing has also been consistently treated as an afterthought. I have personally witnessed significant time loss related to the incomplete preparation of the T/C harnessing.

b) *Creation of a test procedure.*

A test procedure is a living document, and needs to be completed only a few weeks before the doors are closed on the chamber. Typically it does not include the line by line operations required to perform an instrument functional but it does dictate how to arrive at the correct environmental conditions for a given instrument test. This document is what will be redlined as the test proceeds and insight is gained on instrument operations.

c) *Creation of the required software to operate either the GSE, or collect and display data.*

The GSE software used for the temperature collection is far too minimal. An example, when trying to plot what are the trends of the SBS's, the data collection stops. This is plain silly. Another major impediment is that instrument data and the environmental data are on separate systems. The clocks between the two system have not been synchronized so that any searching for cause and effect later in the data reduction will be a nightmare. A three month thermal/vacuum (approximately) test will create a mountain of data. Has either SBRC or GSFC given thought on how the data should be formatted so that it will improve the readability? Tables of raw data, or at best reams of temperature vs. time plots becomes impossible for reviewing exactly what happened during the test. While I do not have a clear idea of what should be done, I do believe some thought needs to be given to this now if we are to have any prayer implementing something before testing.

d) *Allow GSFC to understand the purpose and limitations of the test,*

Having a test plan available becomes something both SBRC & GSFC can point to in terms understanding what the expected data will be from a test. While the PVP is a reasonably good document for the determining the criteria of performance for the entire instrument, there are a lot of instrument subsystems that are being tested without such a clear idea of what are all the purposes of the test.

e) *Reiterates the PAR criteria that the test is to satisfy.*

Every test performed at SBRC for the MODIS should have reference to the PAR that the test is satisfying. This will prevent confusion when in the midst of modifications to the test procedure that are required to be made in near-real time, all the parties concerned would have the minimum requirements at their fingertips.

2. Test Rehearsals

SBRC does not perform daily environmental testing at the Goleta facility. People performing other duties are asked to fill-in to meet the needs for staffing a test. As often as GSFC supports shuttle payload missions, we still perform full system level simulations of our entire GSE several times before a launch. The emphasis of these dress rehearsals is to insure our equipment and people know what is expect for both normal operations and with simulated failures. I believe that it would be very prudent for SBRC to conduct simulate operations of the chamber, and it monitoring software. Thus the debugging of the chamber operations, and control software, and personnel familiarity can be done in parallel to the critical path rather than in series. I would also feel a greater level of comfort if SBRS is practicing chamber operations and failure scenarios without the MODIS within.

6.0 JOSE FLOREZ (Electronics)

The following were the most important issues with the electronics applicable to the last QMR. The first two still need to be addressed, and the last two are actively being worked.

1) The topic of CCA connector alignment to the backplane connectors (not the structural integrity of the boxes) in the three PFM boxes (SAM, FAM, and MEM) needs to be closed. The desire is to verify that the board alignment and tolerances in the three PFM boxes (SAM, FAM, and MEM) is adequate. The request was made after the experience with the misalignment in some of the SAM CCA's was discovered during EM integration. Obviously the concern is that stress applied to the boards and connectors could induce failures during flight.

In order to close this item we need to review the following information for each of the boxes:

1. Documentation (design study, analysis, etc.) that shows what the design parameters are tolerances are for the PFM packaging, to demonstrate adequate alignment.

2. Documentation (EO's, etc.) for modifications made to the EM packaging design for implementation in the PFM.

2) Recovery procedures for determining and handling the position of doors and OBC stepper motors in case of power loss during an active stepping process must be defined. The issue has been addressed in at least three SBRC memos during the last two years, but it has not been resolved.

3) Resolution of the problem with the PC Sipex hybrids.

4) Resolution of the problem with the Microdot 184-pin connectors.

7.0 GERRY GODDEN (MODIS Characterization Support Team member)

Per your request to Ed Knight, I am responding with some notes regarding the December QMR at SBRS since I was the only MCST member in attendance:

Overall, I thought that this review was particularly effective from a calibration-interest perspective. Much progress was demonstrated and many improvements have been, or are being implemented. There was a notable improvement in openness and candor throughout the technical discussions, particularly noteworthy, in that they also were quite attentive to many of our concerns and suggestions.

Key issues and observations from our perspective are:

1) The aft-optics thermal test showed full saturation and low margin (to full saturation) in some bands. SBRS plans to lower the aft-optics operating temperature on-orbit involve

change the thermal finishes on the bottom side of the MODIS. There is a concern with this approach for two reasons:

a) the EOL performance of the paint selected is apparently not sufficient, and

b) MCST is concerned that introducing a third temperature regime (aft-optics temperature about 10 degrees below cavity/case temperature), in addition to the two primary temperature regimes (cavity/case temperature and FPA temperatures) will introduce complexity to the temperature dependent calibration of the thermal bands, i.e., in addition to the three case temperatures and three CFPA temperatures to be evaluated during T/V, there may be a new dependency on aft-optics temperature at high, middle and low points, that should be evaluated to fully and sufficiently characterize the instrument performance. This is an unresolved issue and a considerable risk. We know two significant features about the proposed approach: 1) the instrument performance/staying out of saturation is remarkably sensitive to the aft-optics temperature, and 2) that the proposed thermal finish changes will only marginally meet required aft-optics cooling, even at BOL. It appeared that Tom Pagano does not believe that the additional temperature regime will be a problem for his master curve approach.

2) We learned that the El Segundo ORDAS analysis of the SD and scan cavity (the fourth approach to this analysis) indicates that there should be no problem regarding solar scattering off the edges of the SD bulkhead port. This is reassuring and helpful. We are looking forward to an Internal Memorandum describing this analysis.

3) We learned that El Segundo has completed an ORDAS model of the fore-optics section of MODIS. An update or replacement to the earlier Terry Ferguson APART model. The emphasis with this analysis is apparently on far-field scatter (to compliment the NFR measured results and Jim Young modeling). Only a few highlights were presented. It was surprising to learn that they predict little difference between Cleanliness Levels 300 and 400. This is not consistent with our expectations based on the ratio of the number of particulate scatters. Since we know that far-field scatter can have significant effects on the radiometric accuracy of Level 2 products, and that far-field scatter can not be effectively measured at the system level, these modeling results are very important to characterize the MODIS scatter performance in terms of PSFs. It is hoped and anticipated that this modeling effort will present details of the scan cavity, aperture door, sunshade, and fore-optics which previously have not been available or taken into account. It is not clear why these results are still (6 weeks later) under internal review.

4) We learned in some detail of SBRS's plans to tighten particulate contamination control procedures. Significantly, SBRS states that cleanliness in the T/V area at LMAS will be inadequate. This issue requires more attention. I raise the issue that particulate contamination control procedures must be considered in light of the likely scan mirror pitting from exposure to space micrometeoroids.

5) We learned that there is no flow-down specification for electronic crosstalk to the FPA level. Crosstalk tests on the FPAs apparently have been limited to optical crosstalk measurements.

6) We learned that the NIR Objective lens elements (E1 and E2) bonding had failed; that the new low scatter NIR Objective design was delayed; and that the first assembly replacement hardware will not be available until 3/22. This is very unfortunate since we have already had a 4 week schedule delay and two opportunities to replace this objective, which would go a long ways towards helping to meet the NFR scatter requirements and significantly improve the accuracy of several Level 2 ocean products.

Suggested Action Items as an Outcome of this Review:

1) Provide additional analysis or test data to establish the time response performance of the current Scan Mirror temperature sensor design. The static measurement accuracy requirement for this sensor has been established, but the time response requirement for this sensor has not been established. This should be addressed.

2) Coordinate the SD BRDF measurement and witness sample round-robin tests. Assure that the SD Spectralon spatial uniformity is sufficient to allow transfer of witness sample measurements to the flight article.

3) Provide the calibration traceability report for the OBC BB temperature sensors. It was reported that the PRT's were measured at Hughes Standards Labs. It is important that we be able to trace temperature sensor calibration to NIST standards.

8.0 BOB MARTINEAU (Focal Plane Assemblies)

The QMR presentation showed continuing good progress with some notable setbacks encountered in vibration testing of the Afocal Telescope Assembly, and in reliability of certain electronics parts such as the 184 pin Malco connectors and the Sipex postamplifier hybrids for the PC FAM. These issues are being actively worked.

Progress in the FPA assembly area continues to be excellent. The PF FPAs have of course been delivered. The status of FM1 and FM2 FPA assembly was reviewed. For reasons of economics, SBRS has decided to continue with FPA assembly of all needed units, with a goal of completing this task by about the end of this year, much before the units are needed. It appears that SBRS will achieve this goal.

In the FPA status review the following points were made:

1) FM1 VIS and NIR FPAs have been delivered. These are 100% operable with no performance discrepancies.

2) The FM1 SMWIR DA and FM1 LWIR DA have completed radiometric testing. The SMWIR DA has two soft pixels and an acceptable non-compliant offset at Qlo on B20. The LWIR DA has no soft pixels and an acceptable non-compliance at Qlo on B27-30. In

Unfortunately another lens has cracked during vibration. This makes five lenses (two VIS - I think, one NIR, one SWIR and the fold mirror) and a filter have been damaged during integration, vibration or related activities. THAT IS A LOT! Of course this brings up the question of why (EM optics is not really a excuse) and will anything else break?

Point spread function determination is still not clear to me. Again, after a month all I can remember is line spread function, but no PSF determination. Also, the wavelength dependence of PSF is a not well established.

Will we have a nice clean polarization determination experiment? The discussion did not convince me that we know the causes of the "linear drift".

Far field response will use the heliostat or the flood lamps? Which ever, but let us hope that we have enough time and money to perform the determination because it is a valuable reference point for our scatter models especially as image corrections are planned. Because dust (contamination) is a big factor and it is difficult to predict how much contamination will be in orbit we should not put to much stock in the ground based measurements.

It is time to upgrade the radiometric math models to what I call simulations of the instrument behavior. I will be happy to give a lengthy lecture on this subject. Sooner or later this will be necessary. Later it will be more difficult because the details of the actual design will start looking like ancient history. If we can't put together a model which predicts in reasonable detail the experimental results now it will be even more difficult later.

Let us hope the SRCA works the first time. It is also a complicated instrument.

ACTION ITEMS FROM DECEMBER 1995 MODIS QUARTERLY MANAGEMENT REVIEW

The following action items were generated at the December 1995 MODIS Quarterly Management Review. Responses to these Action Items are due 30 days following receipt.

1. SBRS - Determine the status of the procurement of the second lot of Sipex hybrids.

2. SBRS - Provide updated dates for the TAC Unit Tests.

3. GSFC/MCST - Determine if earth scene data must be preserved if the calibration sector is delayed.

4. SBRS - Provide a date for when the FM1 PC response stability will be measured.

5. SBRS - Provide a price estimate for adding a third fold mirror to the present procurement.

6. SBRS - Assess the vignetting effects due to the thickness of the solar diffuser screen holes.

7. SBRS - Determine the temporal performance of the scan mirror temperature sensor.

8. GSFC/MCST - Clarify what concerns exist over time-stamping of data (querying from metadata).

9. SBRS - Evaluate other possible locations for the QCM.

10. SBRS - Describe the approach for contamination monitoring of the scan mirror assembly in the high bay.

11. GSFC - forward any available documents regarding CERES experience with mirror darkening problems.

TRIP REPORT FROM MR. G. DAELEMANS ON MODIS RADIANT COOLER/AOP THERMAL TESTING

National Aeronautics and
Space Administration
Goddard Space Flight Center
Greenbelt, MD 20771

NASA

Reply to Attn of: 724

December 12, 1995

TO: 704.3/Michael Roberto

FROM: 724.3/George L. Daelemans III

SUBJECT: Trip Report of the Protoflight Radiant Cooler/AOP TV/TB Testing during October 95

Summary

The purpose of this test was two fold; First to demonstrate, with the best simulation as possible, that the MODIS radiant cooler will have temperature margin when the instrument reaches orbit, and; Second, to verify the post Engineering Model (EM) modifications performed to the Aft Optics Platform for reducing the background emissions were sufficient. Briefly, the cooler has a two degree margin (83K vs. spec 85K). Test simulation conditions were, I believe, truly worst case, and that the simulation set-up reduces the on orbit performance by 1.5K to 4.0K. As of my departure it was clear the none of the channels saturated out-right, but since my return it is equally clear that the amount of temperature related background noise has not been reduced enough. The FPA/optics system that were under test will operate without additional fixes at the upper limit of temperature operations currently predicted for the instrument, but not at the prediction plus the 10°C qual limit buffer.

Observations

At contract award for the MODIS instrument the predicted margin for the proposed cooler was on the order of 1.5K. The project wisely decide to buy some margin and approved several changes to the cold stage radiator, outer stage radiator, aperture openings and the dewar stem. It was predicted that these changes would give the cooler an additional 4K or a total of 5.5K beyond our requirements for a 85K set point. The Nominal Temperature Load (NLT) test is essentially a indication of our margin. The unit settle out at 83K during the worst case NLT (mount ring @ EOL temp of 13K). Since we are testing hardware now, rather than analysis, and that the simulator has a few shortcomings while trying to approximate space, I feel comfortable that the instrument's cooler will meet the 85K orbital requirement.

The amount of additional margin from the Space Background Simulator (SBS) is still under analysis. However, our best estimates to date of the improvement are as follows:

1) Cold stage to Cooler SBS effects, these include losses for "seeing" the edge of the outer SBS box, the third stage fin on a single bounce, reduction in stage FOV due to non perfect emittance of the simulator (vs. space), reflected view to intermediate stage. All of these effects yield approximately 1.61K of performance improvement in flight.

2) Intermediate stage reduced FOV from test conditions yields another 0.21K.

3) Fixed temp instrument sink vs. floating instrument on orbit (testing limitation vs. reality) nets an additional 0.65K improvement in orbital performance.

4) The impact of the door sizing between test and flight yields an additional 1.19K, because the simulated door on the test article crowds the FOV more than it would on orbit.

5) Fin radiator FOV differences between test and flight (helps) and the inclusion of the fin's FOV to the earth door (hurts); net orbital effect 0.04K loss of performance from test to orbit.

6) Orbital heat rate as calculated by NASA model vs. SBRS calculations from 1992. Our cold stage loads are higher that SBRS's values but the loading on the intermediate and fin radiator stages are lower. The net effect of this is that our orbital prediction is 0.46K lower than SBRS's heat loads used in this test.

7) Warmer sink temperatures during the test will yield .13K orbital improvement since space is colder.

The summation of these effects is about 3.9K of improvement over what was observed during test, an additional 0.1K is still unaccounted for in the difference between the correlated model in the test conditions and the orbital predictions. This 4K improvement would yield an orbital Nominal Load Temperature of ~79K.

The background noise testing was performed during the first few of the AOP temperature cycles that were performed to meet the PAR thermal requirements. Three basic tests were performed. The first was with the FPA's fixed at 83K while the AOP was changed from one qualification temperature extreme to the opposite temperature extreme. While this was being done the FAM SBS was held at a quasi constant 180K to provide a "known" scene temperature. This sequence was repeated again at a FPA temperature of 85K while also holding the scene plate (a.k.a. FAM SBS) at 180K. The final test was performed with the AOP held constant at the high qualification temperature (29°C) while the FAM SBS was cycled up to 13°C and back to 180K. During each of these thermal events, the data for the FPA's was collected on ten minute intervals so that a smooth curve of the background radiation noise levels could readily correlated with the temperature telemetry. It should be noted that the temperature data collection of the hardware in the chamber is not tied in automatically with the data being collected with the FPA's GSE (called the BAEM). Neil Therrien merged the data sets via a worksheet program after ascertaining difference in the two unit's clocks. While this method of data merging is acceptable for engineering evaluation, I do not think this type of data collection/documentation will be tenable for the Protoflight testing.

Environmental Testing at SBRC

I believe that SBRC needs to become at little more proficient at pulling together the resources for any of the major environmental testing that will be required for the remainder of the MODIS instrument verification. Here is some of my suggestions based on the few tests that I have tried to support at SBRC facilities.

1 Test plans: This simple little document seems to have created more frustration on both SBRC part as well as GSFC. It has always been my view that a test plan should be a short statement of what is to be tested, what the objectives of the test are to be, what equipment is necessary, what is the predicted performance, and any limitations on the test article (i.e. temperature ranges, or less than complete performance). The creation of this document will allow others who will be supporting the test to:

   a) Assembly and or scheduling the needed GSE.

   It seem to be chronic SBRC shortcoming that the minor GSE equipment and the MCC are not prepared until the flight hardware is placed in the chamber. As a re-occurring example, the Thermodynamics units are the most unreliable thermal conditioning units I have work with in 17 years of testing. A tremendous effort is put forth by SBRC's people to maintain schedule only to have any gains lost by the poor performance of these thermal conditioning units. SBRC should have some leverage with the manufacture to better support the performance of these units. The notion that the units can only be fine "tuned" with expensive NASA flight hardware in the chamber is disturbing, especially when I have witnessed a "tuned" unit suddenly lose control and plunge the plumbed space simulator to -100°C in a matter of a few minutes and have no one realize this condition for 15 or 20 minutes. Assembling the temperature telemetry harnessing has also been consistently treated as an afterthought. I have personally witnessed significant time loss related to the incomplete preparation of the T/C harnessing.

   b) Creation of a test procedure.

   A test procedure is a living document, and needs to be completed only a few weeks before the doors are closed on the chamber. Typically is does not include the line by line operations required to perform an instrument functional but it does dictate how to arrive at the correct environmental conditions for a given instrument test. This document is what will be redlined as the test proceeds and insight is gained on instrument operations.

c) Creation of the required software to operate either the GSE, or collect and display data.

The GSE software used for the temperature collection is far too minimal. An example, when trying to plot what are the trends of the SBS's, the data collection stops. This is plain silly. Another major impediment is that instrument data and the environmental data are on separate systems. The clocks between the two system have not been synchronized so that any searching for cause and effect later in the data reduction will be a nightmare. A three month thermal/vacuum (approximately) test will create a mountain of data. Has either SBRC or GSFC given thought on how the data should be formatted so that it will improve the readability? Tables of raw data, or at best reams of temperature vs. time plots becomes impossible for reviewing exactly what happened during the test. While I do not have a clear idea of what should be done, I do believe some thought needs to be given to this now if we are to have any prayer implementing something before testing.

d) Allow GSFC to understand the purpose and limitations of the test.

Having a test plan available becomes something both SBRC & GSFC can point to in terms understanding what the expected data will be from a test. While the PVP is a reasonably good document for the determining the criteria of performance for the entire instrument, there are a lot of instrument subsystems that are being tested without such a clear idea of what are all the purposes of the test.

e) Reiterates the PAR criteria that the test is to satisfy.

Every test performed @ SBRC for the MODIS should have reference to the PAR that the test is satisfying. This will prevent confusion when in the mists of a modifications to the test procedure that are required to be made near real time, all the parties concerned would have the minimum requirements at their fingertips.

2 Test Rehearsals

SBRC does not perform daily environmental testing at the Goleta facility. People performing other duties are asked to fill-in to meet the needs for staffing a test. As often as GSFC supports shuttle payload missions, we still perform full system level simulations of our entire GSE several times before a launch. The emphasis of these dress rehearsals is to insure our equipment and people know what is expect for both normal operations and with simulated failures. I believe that it would be very prudent for SBRC to conduct simulate operations of the chamber, and it monitoring software. Thus the debugging of the chamber operations, and control software, and personnel familiarity can be done in parallel to the critical path rather than in series. I would also feel a greater level of comfort if SBRS is practicing chamber operations and failure scenarios without the MODIS within.

If you should have any questions, please give me a call on extension 6-3301.

George L. Daelemans III

cc:
422/Mr. K. Anderson
422/Mr. T. Anderson
422/Mr. R. Weber
720/Mr. E. Powers
720/Mr. S. Brodeur
724/Mr. R. McIntosh
724/Mr. D. Hewitt
724/Mr. T. Michalek
724/Ms. K. Crossen
SWALES/Mr. D. Powers